

## PATENT ABSTRACTS OF JAPAN

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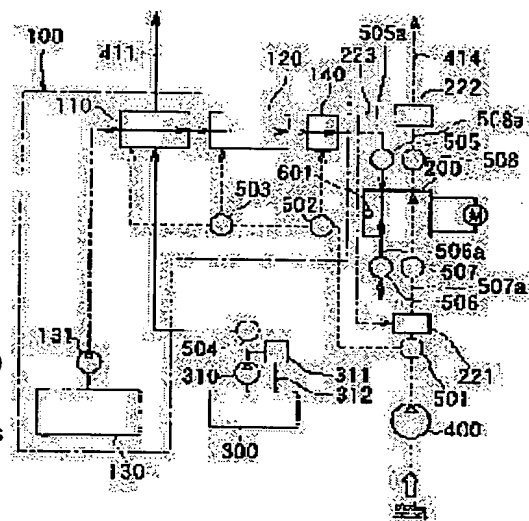
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## (54) FUEL CELL SYSTEM

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To reduce the amount of unreacted hydrogen exhausted from a fuel cell and suppress generation of stress or polymer membrane.

**SOLUTION:** Hydrogen valves 505, 506 are installed on the hydrogen intake side and the hydrogen exhaust side, and the supply of hydrogen to the fuel cell 200 is adjusted with the hydrogen valves 505, 506 so as to intermittently conduct according to the consumption amount of the hydrogen of the fuel cell 200. Air valves (oxygen valves) 507, 508 are installed on the air (oxygen) intake side and the air exhaust side, and the supply of oxygen to the fuel cell 200 is adjusted with the air valves 507, 508 so as to intermittently conduct according to the intermittent supply of hydrogen.



100: 水素供給装置 (水素供給手段)  
200: F.C.スタック (燃料電池)  
505: 第1水素バルブ  
506: 第2水素バルブ  
507: 第1空気バルブ  
508: 第2空気バルブ

## LEGAL STATUS

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CLAIMS

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[Claim(s)]

[Claim 1] The fuel cell system characterized by providing the following. The fuel cell which generates electrical energy according to the chemical reaction of hydrogen and oxygen (200) A hydrogen supply means to supply hydrogen to the aforementioned fuel cell (200) (100) A hydrogen supply adjustment means to adjust so that the hydrogen from the aforementioned hydrogen supply means (100) may be intermittently supplied according to the hydrogen consumption of the aforementioned fuel cell (200) (505 506) An oxygen supply means (400) to supply oxygen to the aforementioned fuel cell (200), and an oxygen supply adjustment means to adjust so that the oxygen from the aforementioned oxygen supply means (400) may be intermittently supplied according to intermittent supply of the aforementioned hydrogen (507 508)

[Claim 2] The 1st hydrogen bulb which the aforementioned hydrogen supply adjustment means is prepared in a hydrogen inflow path (505a), and opens and closes the aforementioned hydrogen inflow path (505), It is the 2nd hydrogen bulb (506) which is prepared in a hydrogen flueway (506a), and opens and closes the aforementioned hydrogen flueway. the aforementioned oxygen supply adjustment means The fuel cell system according to claim 1 characterized by being the 2nd oxygen bulb (508) which is prepared in an oxygen inflow path (507a), is prepared in the 1st oxygen bulb (507) which opens and closes the aforementioned oxygen inflow path, and an oxygen-pumping path (508a), and opens and closes the aforementioned oxygen-pumping path.

[Claim 3] an amount detection means (601) of remains hydrogen to detect the amount of hydrogen in which it exists in the aforementioned fuel cell (200) -- having -- the [ the aforementioned 1st hydrogen bulb (505) and ] -- 2 hydrogen bulb (506) Are opened and closed based on the amount of hydrogen detected by the aforementioned hydrogen detection means (601). the aforementioned 1st oxygen bulb (507) It is the fuel cell system according to claim 2 characterized by being opened and closed according to opening and closing of the aforementioned 1st hydrogen bulb (505), and opening and closing the 2nd oxygen bulb (508) according to opening and closing of the aforementioned 2nd hydrogen bulb (506).

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention applies [ to mobiles, such as vehicles, a vessel, and a portable electric organ, ] about the fuel cell system which consists of a fuel cell which generates electrical energy according to the chemical reaction of hydrogen and oxygen and is effective.

[0002]

[Description of the Prior Art] Since a fuel cell carries out the chemical reaction of hydrogen and the oxygen and generates power like the above-mentioned, it needs to supply hydrogen and oxygen (air) to the hydrogen path and air path which were formed on both sides of the poly membrane according to required electric energy. For this reason, even if it supplies the hydrogen more than required to a fuel cell, unreacted hydrogen will be emitted with exhaust air (a steam, carbon dioxide, etc.).

[0003] By the way, theoretically, although the ratio of the hydrogen and oxygen to supply is 2:1, since no hydrogen can be connected with oxygen but unreacted hydrogen occurs not a little, generally by the actual chemical reaction, more amounts of hydrogen actually supplied to a fuel cell are set up from the theoretical value in consideration of the amount of unreacted hydrogen. For this reason, it is difficult to decrease the amount of unreacted hydrogen discharged from a fuel cell.

[0004]

[Problem(s) to be Solved by the Invention] Then, in order to decrease the amount of unreacted hydrogen discharged from a fuel cell, prepare a bulb in the hydrogen path which supplies hydrogen to a fuel cell, and make hydrogen-rich gas pile up in a fuel cell by opening and closing of this hydrogen bulb, hydrogen is made to fully react, and it is possible to decrease the amount of unreacted hydrogen.

[0005] However, when a hydrogen bulb is closed, hydrogen concentration falls with the hydrogen consumption in a fuel cell, and the hydrogen pressure of the hydrogen path in a fuel cell falls. On the other hand, since air continues being supplied to the air path side in a fuel cell, the differential pressure by the side of the hydrogen path concerning the poly membrane in a fuel cell and an air path becomes high. And when a hydrogen bulb is opened and hydrogen is newly supplied to a hydrogen path side, the differential pressure concerning a poly membrane returns. Therefore, by supplying hydrogen to a fuel cell intermittently by opening and closing of a hydrogen bulb, repeated stress will occur to a poly membrane and a result which is not desirable is brought from the field of endurance.

[0006] this invention aims at suppressing generating of the stress concerning a poly membrane while it decreases the amount of unreacted hydrogen discharged from a fuel cell in view of the point describing above.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, in invention according to claim 1 The fuel cell which generates electrical energy according to the chemical reaction of hydrogen and oxygen (200), A hydrogen supply means (100) to supply hydrogen to a

fuel cell (200), and a hydrogen supply adjustment means to adjust so that the hydrogen by the hydrogen supply means (100) may be intermittently supplied according to the hydrogen consumption of a fuel cell (200) (505 506). It is characterized by having an oxygen supply means (400) to supply oxygen to a fuel cell (200), and an oxygen supply adjustment means (507 508) to adjust so that the oxygen from an oxygen supply means (400) may be intermittently supplied according to intermittent supply of hydrogen.

[0008] Thereby, when the hydrogen concentration in a fuel cell (200) is high, hydrogen can be made to fully react by closing a hydrogen bulb (505 506) and making hydrogen-rich gas pile up in a fuel cell (200). Thereby, the amount of unreacted hydrogen discharged from a fuel cell (200) can be decreased.

[0009] Moreover, according to intermittent supply of hydrogen, by supplying air (oxygen) intermittently, change of the hydrogen concentration in a fuel cell (200) and change of air (oxygen) concentration can be made the same, and the differential pressure of the hydrogen path and air path concerning the poly membrane in a fuel cell (200) can be kept constant. thereby, even if it supplies hydrogen to a fuel cell (200) intermittently, stress generating to a poly membrane can be prevented and the endurance of a poly membrane can be raised

[0010] The 1st hydrogen bulb which the above-mentioned hydrogen supply adjustment means is prepared in a hydrogen inflow path (505a) like invention according to claim 2, and opens and closes a hydrogen inflow path (505). It is prepared in a hydrogen flueway (506a), and can consider as the 2nd hydrogen bulb (506) which opens and closes a hydrogen flueway. an oxygen supply adjustment means It is prepared in an oxygen inflow path (507a), and it is prepared in the 1st oxygen bulb (507) which opens and closes an oxygen inflow path, and an oxygen-pumping path (508a), and can consider as the 2nd oxygen bulb (508) which opens and closes an oxygen-pumping path.

[0011] Moreover, it has an amount detection means (601) of remains hydrogen to detect the amount of hydrogen in which it exists in a fuel cell (200) in invention according to claim 3. It reaches the 1st hydrogen bulb (505). the 2nd hydrogen bulb (506) Are opened and closed based on the amount of hydrogen detected by the hydrogen detection means (601). the 1st oxygen bulb (507) It is characterized by being opened and closed corresponding to opening and closing of the 1st hydrogen bulb (505), and opening and closing the 2nd oxygen bulb (508) corresponding to opening and closing of the 2nd hydrogen bulb (506).

[0012] In addition, the sign in the parenthesis of each above-mentioned means shows a correspondence relation with the concrete means of a publication to the operation form mentioned later.

[0013]

[Embodiments of the Invention] Hereafter, the operation form which applied this invention is explained based on drawing 1 - drawing 4 . This operation form applies the fuel cell system concerning this invention to an electric vehicle (it abbreviates to vehicles hereafter.).

[0014] Drawing 1 is the \*\* type view showing the fuel cell system of this operation form. As shown in drawing 1 , the fuel cell system of this operation form is equipped with the hydrogen manufacturing installation (hydrogen supply means) 100 and fuel cell (FC stack) 200 which were surrounded with the alternate long and short dash line.

[0015] The hydrogen manufacturing installation 100 is a hydrogen manufacturing installation which supplies hydrogen-rich gas to the FC stack 200 to which hydrogen manufactures and (generation) mentions later the hydrogen-rich gas contained so much from the mixed solution (henceforth, methanol mixed solution) of water and a methanol. This hydrogen manufacturing installation 100 carries out the chemical reaction of the methanol steam and steam which evaporated with the fuel evaporator 110 for hydrogen manufacture (the following, evaporator) which evaporates a methanol mixed solution, and the evaporator 110 (evaporation), has the fuel reforming machine (henceforth, reforming machine) 120 grade for hydrogen manufacture reformed to hydrogen, a carbon dioxide, and a small amount of carbon monoxide, and is constituted.

[0016] In addition, methanol mixed-solution tanks 130 which are carried in vehicles and store a methanol mixed solution are consisted of by the evaporator 110 so that a methanol mixed

solution may be sent with the 1st pump 131.

[0017] The FC stack 200 carries out the chemical reaction of the hydrogen-rich gas and air (oxygen) which were manufactured by the hydrogen manufacturing installation 100, and generates them. It is constituted from the fuel cell system of this operation form by the power generated by the FC stack 200 so that the electric motor M for a run may be made to drive. In addition, since a catalyst function tends to fall by the carbon monoxide, the electrode catalyst in the FC stack 200 has formed the carbon monoxide reduction machine 140 which the carbon monoxide generated with the reforming vessel 120 is oxidized, and is changed to a carbon dioxide in the hydrogen manufacturing installation 100 with this operation form.

[0018] The air ventilated by the FC stack 200 is humidified with the air humidifier 221. The exhaust air (a steam, air, etc.) discharged from the FC stack 200 is cooled with a dehumidifier 222, and removal recovery of the moisture is carried out. And the moisture by which separation removal was carried out with the dehumidifier 222 is returned to the air humidifier 221 via the water-of-condensation return path 223, and is reused by humidification of the air ventilated by the FC stack 200.

[0019] Drawing 2 shows the outline composition of the FC stack 200. The FC stack 200 is a solid-state polyelectrolyte type fuel cell, and has a stack structure which carried out two or more laminations of the cell which is a composition unit. As shown in drawing 2, the negative-electrode and positive-electrode side is separated on both sides of the poly membrane 203, the hydrogen path 201 is formed in a negative-electrode side, and, as for each cell of the FC stack 200, the air path 202 is formed in the positive-electrode side. Thereby, hydrogen-rich gas is supplied to a negative-electrode side, and air (oxygen) is supplied to a positive-electrode side. For this reason, from a positive-electrode side, exhaust air containing many steams is discharged and unreacted hydrogen gas, a carbon dioxide, etc. are discharged from a negative-electrode side.

[0020] As shown in drawing 1, the fuel for heating (this operation form methanol) which heats an evaporator 110 is stored in the methanol fuel tank 300 carried in vehicles. The methanol (fuel) stored in the methanol fuel tank 300 is sent to an evaporator 110 with the 2nd pump 310. Some methanols breathed out from the 2nd pump 310 are constituted so that it may be returned to the methanol fuel tank 300 through the methanol return path 312. The methanol return path 312 is opened and closed by the fuel return valve 311.

[0021] The combustion exhaust gas which inhaled the open air by the air pump (oxygen supply means) 400, was ventilated by the hydrogen manufacturing installation 100 (an evaporator 110 and reforming machine 120) and the FC stack 200, and was generated in the hydrogen manufacturing installation 100, and the exhaust air generated in the FC stack 200 circulate flueways 411-414, and is emitted into the atmosphere.

[0022] While the ventilation air breathed out from an air pump 400 is distributed to the hydrogen manufacturing installation 100 and the FC stack 200 by the 1st air distribution bulb 501, the amount of distributions is adjusted. While the air distributed to the hydrogen manufacturing installation 100 side by the 1st air distribution bulb 501 is distributed to an evaporator 110, the reforming machine 120, and the carbon monoxide reduction machine 140 by the 2nd and 3 air distribution bulbs 502 and 503, the amount of distributions is adjusted.

[0023] While the methanol supplied from the methanol fuel tank 300 is supplied to an evaporator 110 and the reforming machine 120 by the methanol bulb 504, the amount of supply is adjusted.

[0024] The hydrogen-rich gas supplied from the hydrogen manufacturing installation 100 is supplied to the FC stack 200 (negative-electrode side) through hydrogen inflow path 505a, and hydrogen inflow path 505a is opened and closed by the 1st hydrogen bulb 505. Hydrogen flueway 506a of the FC stack 200 is opened and closed by the 2nd hydrogen bulb 506. In addition, with this operation form, it is emitted into the atmosphere as well as [ the exhaust air from hydrogen flueway 506a by the side of a negative electrode ] a flueway 414.

[0025] It is breathed out from an air pump 400 and the ventilation air distributed to the FC stack 200 side by the 1st air distribution bulb 501 is supplied to the FC stack 200 (positive-electrode side) through airstream close path (oxygen inflow path) 507a. Airstream close path 507a is opened and closed by the 1st air bulb (the 1st oxygen bulb) 507. Air flueway (oxygen-pumping

path) 508a by the side of the positive electrode of the FC stack 200 is opened and closed by the 2nd air bulb (the 2nd oxygen bulb) 508.

[0026] Drawing 3 is the control-block view of a fuel cell system. As shown in drawing 1 and drawing 3, the hydrogen sensor (the amount detection means of remains hydrogen) 601 which detects the hydrogen concentration (the amount of hydrogen) which exists in the FC stack 200 (negative-electrode side) is formed in the fuel cell system of this operation form. As shown in drawing 3, the detecting signal of the hydrogen sensor 601 is inputted into the FC system controller (following, FCCU) 600 which controls the whole fuel cell system. And the 1-3rd air distribution bulbs 501-503, the methanol bulb 504, the 1st, the 2nd hydrogen bulbs 505 and 506, the 1st, and the 2nd air bulbs 507 and 508 are controlled by FCCU600 based on the detecting signal of the sensor groups S which carry out operational status detection, such as a detecting signal of the hydrogen sensor 601, and temperature of the FC stack 200, a load of the electric motor for a run.

[0027] Next, the operation of the 1st hydrogen bulb 505 of the fuel cell system in this operation form is explained based on drawing 4. Drawing 4 is a graph which indicates the relations of the opening-and-closing timing of the 1st and the 2nd air bulbs 507 and 508 to be the amount of hydrogen (remains hydrogen concentration in FC stack) which the hydrogen sensor 601 detected, the opening-and-closing timing of the 1st and the 2nd hydrogen bulbs 505 and 506, and the remains air concentration in FC stack.

[0028] it is shown in drawing 4 -- as -- the remains hydrogen concentration in the FC stack 200 -- the 1st -- when it becomes less than [ predetermined concentration (predetermined remains hydrogen concentration) d1 ], the 1st hydrogen bulb 505 by the side of a hydrogen inflow is opened, and hydrogen is supplied to the negative-electrode side of the FC stack 200. Thereby, hydrogen-rich gas is supplied to the FC stack 200 through hydrogen inflow path 505a from the hydrogen supply equipment 100, and the hydrogen concentration in the FC stack 200 rises. At this time, the 1st air bulb 507 by the side of airstream close is also opened simultaneously with the 1st hydrogen bulb 505, air (oxygen) is supplied to the positive-electrode side of the FC stack 200, and the air concentration in the FC stack 200 as well as hydrogen concentration rises.

[0029] next, the 2nd with the larger hydrogen concentration in the FC stack 200 than the 1st predetermined concentration d1 -- when it becomes more than predetermined concentration d2, the 1st hydrogen bulb 505 is closed and the hydrogen supply to the FC stack 200 is stopped. At this time, the 1st air bulb 507 is also closed simultaneously with the 1st hydrogen bulb 505, and the air supply to the FC stack 200 is stopped. Within the FC stack 200, while generating electricity according to the chemical reaction of hydrogen and oxygen, hydrogen and air (oxygen) are consumed and air concentration falls with hydrogen concentration. In connection with this, the amount of power generation of the FC stack 200 falls gradually.

[0030] next, the hydrogen concentration in the FC stack 200 -- the 1st -- when it becomes less than [ predetermined concentration d1 ], the 1st hydrogen bulb 505 is opened and new hydrogen-rich gas is supplied to the FC stack 200 from the hydrogen feeder 100. Simultaneously, the 1st air bulb 507 is opened and new air is supplied to the FC stack 200.

[0031] On the other hand, the 2nd hydrogen bulb 506 of a hydrogen exhaust side operates so that it may close earlier than the time (timing) of opening earlier than the time (timing) of the 1st hydrogen bulb 505 opening, and the 1st hydrogen bulb 505 closing. The 2nd air bulb of an air exhaust side also operates to the same timing as the 2nd hydrogen bulb 508. The time which both the 1st hydrogen bulb 505, the 2nd hydrogen bulb 506 and the 1st air bulb 507, and the 2nd air bulb 508 are opening occurs by this, and the residual gas which exists in a negative-electrode [ in the FC stack 200 ] and positive-electrode side can be promptly discharged with the hydrogen and air which are newly supplied.

[0032] Henceforth, as shown in drawing 4, according to consumption of the hydrogen in the FC stack 200, opening and closing of the 1st, the 2nd hydrogen bulbs 505 and 506, and the 1st and the 2nd air bulbs 507 and 508 are repeated, and hydrogen and air (oxygen) are intermittently supplied to the FC stack 200.

[0033] as mentioned above, the thing for which the hydrogen bulbs 505 and 506 prepared in the hydrogen path are opened and closed according to the hydrogen consumption in the FC stack

200 according to the fuel cell system of this operation gestalt — the FC stack 200 — hydrogen-rich gas — being intermittent (intermittent) — it can supply. When close the hydrogen bulbs 505 and 506, make hydrogen-rich gas pile up in the FC stack 200, and hydrogen is made to fully react by this, when the hydrogen concentration in the FC stack 200 is high, and the hydrogen concentration in the FC stack 200 becomes low, while opening the hydrogen bulbs 505 and 506 and discharging residual gas from the inside of the FC stack 200, new hydrogen-rich gas is supplied. Thereby, the amount of unreacted hydrogen discharged from the FC stack 200 can be decreased.

[0034] Moreover, in the fuel cell system of this operation gestalt, since the 1st and the 2nd air bulbs 507 and 508 are formed in an air duct and it is made to open and close to the same timing as the hydrogen bulbs 505 and 506, as shown in drawing 4, change of the hydrogen concentration in the hydrogen path 201 in the FC stack 200 and change of the air concentration in the air path 202 can be made the same. Thereby, the differential pressure of the hydrogen path 201 and the air path 202 concerning the poly membrane 203 in the FC stack 200 can be kept constant. therefore, even if it supplies hydrogen to the FC stack 200 intermittently, stress generating to the poly membrane 203 by the differential pressure of the hydrogen path 201 and the air path 202 can be prevented, and the endurance of a poly membrane 203 can be raised

[0035] (others — operation gestalt) in addition, with the above-mentioned operation gestalt, although it formed the hydrogen bulbs 505 and 506 and two air bulbs 507 and 508 at a time in the exhaust side the inflow side of the FC stack 200, respectively, the 1st hydrogen bulb 505 and the 1st air bulb 507 not only this but by the side of an inflow are also omissible. In this case, the 2nd hydrogen bulb 506 of a hydrogen exhaust side is opened and closed, supply and exhaust air of the hydrogen to the FC stack 200 are performed based on the hydrogen concentration in the FC stack 200 detected by the hydrogen sensor 601, the 2nd air bulb 508 of an air exhaust side is opened and closed similarly, and supply and exhaust air of the air (oxygen) to the FC stack 200 are performed.

[0036] With the above-mentioned operation gestalt, although direct detection of the hydrogen concentration in the FC stack 200 was carried out by this hydrogen sensor 601, using the hydrogen sensor 601 as a remains hydrogen concentration detection means, based on the physical quantity relevant to the hydrogen concentration not only this but in the FC stack 200, you may detect the hydrogen concentration in the FC stack 200 indirectly.

[0037] For example, by detecting the electric energy (the amount of current) outputted from the FC stack 200, using a current detector (current detection means) as a remains hydrogen concentration detection means, since it is proportional to the amount of current outputted from the FC stack 200, you may constitute the amount of hydrogen consumed by the FC stack 200 so that the remains hydrogen concentration in the FC stack 200 (the amount of remains hydrogen) may be detected indirectly. Moreover, using a pressure sensor (pressure detection means) as a remains hydrogen concentration detection means, by detecting the gas pressure in the FC stack 200 (negative-electrode side), you may constitute so that the remains hydrogen concentration in the FC stack 200 (the amount of remains hydrogen) may be detected indirectly.

[0038] Moreover, with the above-mentioned operation gestalt, although this invention was applied to the electric vehicle, this invention is not limited to this and can be applied also to non-portable fuel cell systems, such as home use.

[0039] Moreover, although the hydrogen manufacture machine 100 which manufactures the hydrogen-rich gas in which the fuel of a hydrocarbon system was reformed as a hydrogen supply means, and hydrogen was contained so much was used with the above-mentioned operation gestalt, this invention is not limited to this and may use the high-pressure hydrogen tank which can supply pure hydrogen gas as a hydrogen supply means, the hydrogen tank using the hydrogen storing metal alloy, etc.

[0040] In addition, since any impurities other than hydrogen are not contained in the hydrogen supplied to the FC stack 200 in this case, a carbon dioxide etc. does not remain to the FC stack 200. Therefore, after closing the 2nd hydrogen bulb 506, you may close the 1st hydrogen bulb 505.



[0041] Although it pressurizes and hydrogen is incidentally supplied to the FC stack 200 in the fuel cell system for electric vehicles, home use etc. may supply hydrogen to the FC stack 200 in a non-portable fuel cell system, without pressurizing. In this case, after opening the 1st hydrogen bulb 505, it is desirable to open the 2nd hydrogen bulb 506.

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] It is the \*\* type view of the fuel cell system concerning the above-mentioned operation gestalt.

[Drawing 2] It is the \*\* type view of FC stack.

[Drawing 3] It is the control-block view of the fuel cell system concerning the above-mentioned operation gestalt.

[Drawing 4] It is the graph which shows the relation of the hydrogen concentration in FC stack, the opening-and-closing timing of the hydrogen bulbs 505 and 506, the air concentration in FC stack, and the opening-and-closing timing of the air bulbs 507 and 508.

[Description of Notations]

100 [ -- The 1st hydrogen bulb, 506 / -- The 2nd hydrogen bulb. ] -- A hydrogen manufacturing installation (hydrogen supply means), 200 -- FC stack (fuel cell), 505 507 -- The 1st air bulb, 508 -- The 2nd air bulb.

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[Translation done.]